

POWER PLANT INSTRUMENTATION
(AEIE 4231)

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) In a steam power station, the choice of high temperature steam is for
(a) increasing the efficiency of boiler alone
(b) increasing the efficiency of turbine alone
(c) increasing overall efficiency
(d) none of the above.
- (ii) Match the followings (cause-effect)
- | | |
|------------------------|--|
| 1. Feed water Hardness | A. Corrosion |
| 2. Dissolve Oxygen | B. Low pH |
| 3. Coagulation | C. Chlorides and sulphates and Nitrates of Calcium and magnesium |
| 4. Scale formation | D. Alum Foaming |
| (a) 1-C, 2-D, 3-B, 4-A | (b) 1-C, 2-A, 3-D, 4-B |
| (c) 1-A, 2-D, 3-C, 4-B | (d) 1-B, 2-C, 3-D, 4-A. |
- (iii) Zirconium probe is commonly used to analyse _____ content of flue gas.
(a) O₂ (b) CO₂ (c) NO_x (d) SO_x
- (iv) Swelling of boiler drum level occurs when
(a) Load demand decreases (b) Load demand increases
(c) Boiler pressure decreases (d) All of the above.
- (v) The fluctuation of load demand is successfully countered by
(a) 1-element drum level control (b) 2-element drum level control
(c) 3-element drum level control (d) None of these.
- (vi) Reheat cycle in steam power plant is used to
(a) Utilize heat of flue gases (b) Increase thermal efficiency
(c) Improve condenser performance (d) Reduce loss of heat.

- (vii) Which one is essential for combustion of fuel?
(a) Oxygen to support combustion (b) Correct fuel air ratio
(c) Proper ignition temperature (d) All the three above.
- (viii) In hydro power plant _____ is converted into mechanical energy.
(a) Potential energy (b) Kinetic energy
(c) Wind energy (d) Both potential and kinetic energy
- (ix) What is the function of heavy water in a nuclear reactor?
(a) It serves as a coolant
(b) It serves as moderator
(c) It serves as a coolant as well as a moderator
(d) It serves as a neutron absorber.
- (x) Blade erosion in steam turbines takes place
(a) due to high temperature steam (b) due to high rotational speed
(c) due to droplets in steam (d) due to high flow rate.

Group - B

2. (a) Describe the cooling water circuit using the relevant schematic drawings.
[(C01)(Understand/LOCQ)]
(b) Draw and describe the configuration of the ash collection and transportation system.
[(C01)(Remember/LOCQ)]
(c) How do an air preheater and an economiser benefit furnace efficiency?
[(C01)(Analyse/IOCQ)]
4 + 5 + 3 = 12
3. (a) What do you mean by furnace draft? Why furnace draft is maintained slightly below atmospheric pressure?
[(C01)(Remember/LOCQ, Analyse/IOCQ)]
(b) Why is it necessary to use superheated steam for turbine? Explain how the superheated steam improves the efficiency of the reheat Rankin cycle using a T-S diagram.
[(C02)(Analyse/IOCQ, Evaluate/HOCQ)]
(2 + 3) + (3 + 4) = 12

Group - C

4. (a) What do you mean by purging? Indicate the conditions that must be met before the burner firing order is initiated for a pulverised coal-fuelled boiler.
[(C04)(Understand/LOCQ, Analyse/IOCQ)]
(b) State the boiler tripping conditions as per the NFPA code recommendation.
[(C04)(Understand/LOCQ)]
(2 + 6) + 4 = 12
5. (a) State the ways of generating load demand control signal for the furnace firing.
[(C03)(Understand/LOCQ)]

- (b) Explain, using the appropriate graphs, how extra air affects boiler efficiency.
[[CO3](Analyse/IOCQ)]
- (c) Discuss best control scheme adopted for steam temperature control during dynamic load condition.
[[CO3](Analyse/IOCQ)]
- (4 + 3) + 5 = 12**

Group - D

6. (a) Why safety interlock system is important for a thermal power plant.
[[CO4](Understand/LOCQ)]
- (b) The starting sequence of various boiler auxiliaries is configured as follows: (i) Regenerative air heaters, (ii) Induced draft (ID) fans, (iii) Forced draft (FD) fans, (iv) Primary air (PA) fans, (v) Pulverisers and (vi) Coal feeders. Design stop interlock system using logic gates.
[[CO4](Create/HOCQ)]
- (c) State the importance of Turbine Supervisory Instrumentation (TSI) system.
[[CO5](Remember/LOCQ)]
- 3 + 6 + 3 = 12**
7. (a) Why is it important to control the temperature of the lubricating oil used in turbine bearing housing? Describe the temperature control scheme with necessary P&I diagram.
[[CO5](Apply, Analyse/IOCQ)]
- (b) State the importance of turbine shaft vibration measurement. Name two sensors that can be used to measure shaft vibration.
[[CO5](Analyse/IOCQ)]
- (c) Draw the schematic for measurement of turbine shaft vibration and explain the same.
[[CO5](Analyse/IOCQ)]
- (2 + 3) + 4 + 3 = 12**

Group - E

8. (a) Name the common dissolved salts and minerals present in raw water. Discuss how they cause issues with the running of a thermal power plant.
[[CO6](Remember/LOCQ, Analyse/IOCQ)]
- (b) Describe any two mechanical methods for raw water treatment.
[[CO6](Understand/LOCQ)]
- (2 + 4) + 6 = 12**
9. (a) Describe selective catalytic reduction method of NO_x emission control used in thermal power plant.
[[CO6](Understand/LOCQ)]
- (b) Describe typical layout of a hydroelectric power plant.
[[CO1](Analyse/IOCQ)]
- (c) State the desirable properties of coolant used in nuclear power plant.
[[CO1](Remember/LOCQ)]
- 3 + 5 + 4 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	37.50	48.96	13.54

Course Outcome (CO):

After the completion of the course students will be able to

1. Describe the main equipment of a power plant.
2. Explain the thermodynamic cycles used thermal power plant.
3. Give details of instrumentation and control loops in thermal power plant.
4. Include safety interlocks necessary for safe operation of thermal power plant.
5. Describe the turbine supervisory instrumentation system.
6. Gain knowledge about water treatment system and Pollution measurement and regulation of NO_x, SO_x and CO_x.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question;
HOCQ: Higher Order Cognitive Question